

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 29 MAR 2005

W/PC PCT

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| Applicant's or agent's file reference DHTG0082 | FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) | |
| International application No. PCT/EP 03/05390 | International filing date (<i>day/month/year</i>) 23.05.2003 | Priority date (<i>day/month/year</i>) 22.01.2003 |
| International Patent Classification (IPC) or both national classification and IPC C02F1/44 | | |
| Applicant MANTH, Thomas | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 11 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

I ☒ Basis of the opinion

II ☐ Priority

III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability


IV ☐ Lack of unity of invention

V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI ☐ Certain documents cited

VII ☐ Certain defects in the international application

VIII ☐ Certain observations on the international application

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| Date of submission of the demand 23.08.2004 | Date of completion of this report 21.03.2005 |
| Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016 | Authorized Officer Hoornaert, P Telephone No. +31 70 340-2323 |



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP 03/05390

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-23 as originally filed

Claims, Numbers

1-11 received on 12.01.2005 with letter of 11.01.2005

Drawings, Sheets

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | |
|-------------------------------|-------------|------|
| Novelty (N) | Yes: Claims | 1-11 |
| | No: Claims | |
| Inventive step (IS) | Yes: Claims | 1-11 |
| | No: Claims | |
| Industrial applicability (IA) | Yes: Claims | 1-11 |
| | No: Claims | |

2. Citations and explanations

see separate sheet

Re Item I

Basis of the report

With his letter of reply of 11.01.2005 the applicant submitted a revised set of claims. The amended claims are considered to fulfil the requirements of Article 34(2)(b) PCT, except for the omission from claim 1 of the feature that the high-pressure pump is driven at a constant number of revolutions by a first motor. Said omission introduces subject-matter which extends beyond the content of the application as filed.

The application as originally filed, i.e. the embodiment corresponding to claim 1 and figure 1, does not disclose any high-pressure pump driven by a three-phase motor, but only a high-pressure pump operating at a constant number of revolutions (see description on page 6, lines 13-19; page 8, lines 6-10; and page 18, lines 13-16). In this connection, it is pointed out that in the set of claims as originally filed, claim 4 is dependent on claim 2 and claim 3, and does not directly depend on claim 1.

Consequently, upon incorporation of the additional features of claims 3 and 4 as originally filed into claim 1, at least the feature of dependent claim 2 that the high-pressure pump is driven at a constant number of revolutions by a first three-phase motor was not incorporated into claim 1.

This report has been established as if amended claim 1 contained the feature identified above (see also item V, point 2.1 below).

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

- D1: FR-A-2 281 782 (DANSKE MEJERIERS MASKINFABRIK) 12 March 1976 (1976-03-12)
- D2: DE 299 07 813 U (HACO WASSERTECHNIK GMBH) 26 August 1999 (1999-08-26)
- D3: US-A-6 139 740 (OKLEJAS ROBERT A) 31 October 2000 (2000-10-31)

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D4: US-B1-6 468 431 (OKLELAS JR ELI) 22 October 2002 (2002-10-22)
D5: US-A-4 973 408 (KEEFER BOWIE G) 27 November 1990 (1990-11-27)
D6: DE 35 10 160 A (WEINRICH HELLMUT) 25 September 1986 (1986-09-25)
D7: PATENT ABSTRACTS OF JAPAN vol. 2000, no. 21, 3 August 2001 (2001-08-03) -& JP 2001 104954 A (KIKAI KAGAKU KENKYUSHO:KK;NISHI NIPPON RYOJU KOSAN KK), 17 April 2001 (2001-04-17), -& DATABASE WPI Derwent Publications Ltd., London, GB; AN 2001-351348 (*)

2.1 It is clear from the description on page 6, lines 13-19 ("In the water desalination device as defined by the invention, the pressure in the raw water feed line is exclusively controlled by varying the capacity of the pressure booster pump. The high-pressure pump operates continually at a fixed number of revolutions .."); on page 6, line 19 to page 7, line 2 ("According to the invention, the pressure booster pump .. rated for a distinctly lower power requirement than the high-pressure pump."), and on page 8, lines 6-12 that the following feature is essential to the definition of the invention as claimed in claim 1:

(1) the high-pressure pump is driven at a constant number of revolutions (see also item I above), and

(2) the second three-phase motor has a distinctly lower output than the first three-phase motor.

2.2 It is clear from the description on page 14, lines 14-22 ("As described above, this motor drive has ..") that the following feature is essential to the definition of the invention as claimed in claim 8:

(3) the motor drive of the pressure booster pump has a distinctly lower power level as compared to the drive of the high-pressure pump.

2.3 Since independent claim 1 does not contain features (1) and (2), and since independent claim 8 does not contain feature (3) they do not meet the requirement

following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention, or, in other words, necessary for the solution of the problem to which the invention relates (see point 3.2 below).

- 3.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (see passages as highlighted in the Search Report, the references in parentheses applying to this document) a water desalination installation comprising at least one reverse osmosis membrane module; a feed pump (18); an energy recovery unit comprising a motor-driven circulation pump (20) arranged in the raw water feed line between the feed pump (18) and the membrane module; and a hydraulic motor (30) arranged in the concentrate line and mechanically coupled with the feed pump (18). The feed pump (18) is also driven by a three-phase motor (24), the number of revolutions of which can be controlled by means of a variable frequency drive (32).

It is credible that feed pump (18) is a high-pressure pump, since pump (20) is a circulation pump.

The subject-matter of claim 1 (see point 2.1 above (essential features missing), as well as the objection made at item I (added subject-matter)) differs from this known installation in that according to the invention (1) the high-pressure pump is driven at a constant number of revolutions, (2) the pressure booster pump, (and not the high-pressure pump as in D1), is driven by a three-phase motor, the number of revolutions of which can be controlled by means of a variable frequency drive, and in that (3) the pressure booster pump is also driven by a turbine arranged in the concentrate line, the output of the second three-phase motor of the pressure booster pump being distinctly lower than the output of the first three-phase motor of the high-pressure pump. D1 is silent on the relation of the outputs of the two motors.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

- 3.2 The problem to be solved by the present invention may be regarded as to provide an improved water desalination installation that can be employed on the large technical scale of seawater desalination and permits adaptation to fluctuating conditions (such

as temperature and salt concentration of the raw water) with maximum energy efficiency (see description, paragraph bridging pages 5 and 6).

According to the invention the operating point of the installation is adapted by controlling the capacity of the pressure booster pump, instead of controlling the capacity of the high-pressure pump as in D1, by means of a variable frequency drive. Variable frequency drives in the output range of a driving motor of the high-pressure pump (i.e. several hundred kW's to several MW's as defined in claim 1) are not readily available in the market and are extremely expensive, susceptible to defects, and also maintenance-intensive because of the special power semiconductors that have to be used. Furthermore, such variable frequency drives cause non-negligible losses of electrical energy. A further drawback is caused by the fact that the high-pressure pump is capable of operating with the maximum degree of efficiency only at a fixed number of revolutions. A variation of the number of revolutions for the purpose of adjusting the operating point of the water desalination installation leads to the fact that the high-pressure pump operates with a lower degree of efficiency, which in turn leads to high energy losses (see description, on page 5). All said drawbacks are overcome by the solution now proposed in claim 1.

3.3 Said solution is not obvious in the light of the prior art.

D6 (see passages as highlighted in the Search Report) discloses a water desalination installation comprising at least one reverse osmosis membrane module; a high-pressure pump (6); a permeate line; a concentrate line and an energy recovery unit comprising a low-pressure pump (2) (i.e. a pressure booster pump) arranged in the raw water feed line before the high-pressure pump (6) and the membrane module; and a turbine (13) arranged in the concentrate line and mechanically coupled with the high-pressure pump (6). The low-pressure pump (2) (i.e. the pressure booster pump) is driven by an electric motor (3), the number of revolutions of which can be controlled. A variable frequency drive is not explicitly disclosed in D6.

D7 (see abstracts, figures, and translated document, in particular paragraph [0014]) discloses a water desalination installation for the desalination of seawater comprising a first reverse osmosis membrane module; a high-pressure pump (P1); a first concentrate line, via which concentrated salt water is discharged from the first

membrane module to a second membrane module; a pressure booster pump (P2) being arranged in the first concentrate line between the first and the second membrane modules, and a turbine in the second concentrate line from the second membrane module and mechanically coupled with the high-pressure pump (P1). The "rotational frequency" of the motor of the pressure booster pump (P2) is controlled by an "inverter" (I). It is believed that said "inverter I" is a variable frequency drive within the meaning of the present invention.

However, the prior art gives no indications which could bring the skilled person to the idea of applying the control of the number of revolutions of the motor of the low-pressure pump known from D6, or the use of an "inverter" on the motor of the pressure booster pump known from D7, to the circulation motor (20) of D1, and this in the expectation that by doing so, he would solve the problem mentioned under point 3.2 above. Moreover, even a mosaic of D1 and D6 or D7 does not result in the subject-matter of claim 1.

Consequently, the solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT).

- 4.1 The document D3 is regarded as being the closest prior art to the subject-matter of independent claim 8, and discloses (see passages as highlighted in the Search Report) a multi-stage water desalination installation comprising all the features of the preamble of claim 8.

The subject-matter of claim 8 (see point 2.2 above (essential feature missing)) differs essentially from this known installation in that according to the present invention the pressure booster pump is driven by a three-phase motor, the number of revolutions of which is controllable by means of a variable frequency drive, wherein the motor drive of the pressure booster pump has a distinctly lower power level as compared to the drive of the high-pressure pump, whereas according to D3 the pressure booster pump (pump P of turbocharger 108) is only driven by a turbine, and not by an electric motor.

D4 discloses (see passages as highlighted in the Search Report) a multi-stage water desalination installation wherein the booster pump is either motor-driven or turbine-

driven. D4 does not disclose a branch in the second concentrate line between the second membrane module and the first turbine, via which concentrated salt water can be supplied to a second turbine, the latter being mechanically coupled with the high-pressure pump, and whereby provision is made between the branch and the second turbine for a throttling valve.

D7 (see point 3.3 above) does also not disclose such a branch, nor a throttling valve. Moreover, the pressure booster pump of D7 is only driven by a motor, not by a turbine.

The subject-matter of claim 8 is therefore new (Article 33(2) PCT).

- 4.2 The same operational principle on which the invention as claimed in claim 1 is based, which is the adaptation of the operating point by means of a pressure booster pump, such a pump being driven by means of a turbine that is arranged in the concentrate line, can be applied in the multi-stage water desalination installation according to claim 8 as well (see description on page 13, first paragraph).

The problem to be solved in this connection is to again to provide an improved water desalination installation that can be employed on the large technical scale of seawater desalination and permits adaptation to fluctuating conditions (such as temperature and salt concentration of the raw water) with maximum energy efficiency, but now in a multi-stage water desalination installation by adapting the operating point in the first concentrate line, via which the concentrate to be desalinated is supplied to the second membrane module (see description on page 13, last paragraph).

The same arguments as mentioned at points 3.2 to 3.3 for claim 1 above apply *mutatis mutandis* to independent claim 8 directed to multi-stage water desalination installation. In this connection, it is pointed out that since the pressure booster pump in D3 is not driven by an electric motor, incorporation of a variable frequency drive is clearly impossible.

Consequently, the solution to this problem proposed in claim 8 of the present application is considered as involving an inventive step (Article 33(3) PCT).

5. Independent use claim 10 is to be construed as a claim directed to a process claim for the process of water desalination using an installation according to claims 1 to 7 and containing an energy recovery unit comprising a pressure booster pump and a Pelton turbine.

Consequently, independent claim 10 automatically meets the requirements of the PCT with respect to novelty and inventive step.

6. Claims 2-7, 9 and 11 are respectively dependent on claims 1, 8 and 10 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

- 7.1 Claims 1 and 8 are not clear (Article 6 PCT) for the following reasons:

-the feature ".. can be controlled by means of a variable frequency drive" in the apparatus claim 1, and the feature ".. controllable" in claim 8 both relate to a method of using the apparatus rather than clearly defining the apparatus in terms of its technical features. The intended limitations are therefore not clear from this claim. The term "is controlled" is considered to be an apparatus feature,

-the feature "the first three-phase motor has an output ranging from several hundred kW's to several MW's" (see description on page 5, lines 3-4 and on page 8, lines 19-20) expresses the distinctly higher output of the first three-phase motor more clearly than the expression "the first three-phase motor has an output ranging from a few hundred kW's to a few MW's" used in claim 1, and

-the expressions "a second three-phase motor (12)" and "the first three-phase motor" used in claim 1 are not correct, since a first three-phase motor has not been defined earlier.

- 7.2 The two-part form is unsuitable for independent claim 1 (see PCT/GL/ISPE, part I, Chapter 5, 5.06(iii)).

- 7.3 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 and D3-D7 is not mentioned in the description, nor are these documents identified therein.

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- 7.4 The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

DHTG0082 (908/03)
D80\D549
AY

(Amended) Claims

1. A water desalination installation for the desalination of seawater according to the reverse osmosis method, comprising at least one membrane module (1) that is connected with a raw water feed line (2), via which raw water is supplied by means of a high-pressure pump (3); a permeate line (5), via which the desalinated water is discharged; as well as a concentrate line (6), via which concentrated salt water is discharged; an energy recovery unit (8) comprising a motor-driven pressure booster pump (9) arranged in the raw water feed line (2) either before the high-pressure pump (3) or between the high-pressure pump (3) and the membrane module (1); characterized in that a first turbine (11) is arranged in the concentrate line (6) and mechanically coupled with the pressure booster pump (9), wherein the pressure booster pump (9) is driven by a second three-phase motor (12), the number of revolutions of which can be controlled by means of a variable frequency drive (13), wherein the first three-phase motor (4) has an output ranging from a few

hundred kW's to a few MW's, whereas the second three-phase motor (12) has a lower output than the first three-phase motor (4), ranging from a few kW's to a few hundred kW's.

2. The water desalination installation according to claim 1, characterized in that the high-pressure pump (3) is a multi-stage, first centrifugal pump driven at a constant number of revolutions by a first three-phase motor (4).

3. The water desalination installation according to any one of claims 1 and 2, characterized in that the pressure booster pump (9) is a second centrifugal pump, whereby the second centrifugal pump and the first turbine (11) are arranged on a common drive shaft (10).

4. The water desalination installation according to any one of claims 1 to 3, characterized in that provision is made for a branch (14) in the concentrate line (6) between the membrane module (1) and the energy recovery unit (8), via which branch concentrated salt water can be supplied to a second turbine (15), the latter being mechanically coupled with the high-pressure pump (3).

5. The water desalination installation according to claim 4, characterized in that provision is made between the branch (14) and the second turbine (15) for a throttling valve (16).

6. The water desalination installation according to any one of claims 1 to 5, characterized in that the first and/or the second turbine(s) are Pelton turbines.

7. The water desalination installation according to any one of claims 1 to 6, characterized in that the first and/or the second turbines are Francis turbines with adjustable guide vanes.

8. A water desalination installation for the desalination of seawater according to the reverse osmosis method, comprising a first membrane module (18) connected with a raw water feed line (19), via which raw water is supplied by means of a high-pressure pump (20); a first permeate line (21), via which desalinated water is discharged; a first concentrate line (22), via which concentrated salt water is discharged from the first membrane module (18); and a second membrane module (23), which is supplied with concentrated salt water by way of

the first concentrate line (22), whereby the second membrane module (23) is connected with a second permeate line (24), via which desalinated water is discharged, and with a second concentrate line (25), via which concentrated salt water is discharged; a pressure booster pump (26) being arranged in the first concentrate line (22) between the first and the second membrane modules, and by a first turbine (28), said turbine being arranged in the second concentrate line (25) and mechanically coupled with the pressure booster pump (26); whereby provision is made in the second concentrate line (25) between the second membrane module (23) and the first turbine (28) for a branch (29), via which concentrated salt water can be supplied to a second turbine (31), the latter being mechanically coupled with the high-pressure pump (20); and whereby provision is made between the branch (29) and the second turbine (31) for a throttling valve (30), characterized in that the pressure booster pump (26) is driven by a three-phase motor (33), the number of revolutions of which is controllable by means of a variable frequency drive (34).

9. The water desalination installation according to claim 8, characterized in that the first and/or the second turbines are Pelton turbines.

10. Use of an energy recovery unit comprising a pressure booster pump (9) and a Pelton turbine (11), whereas the pressure booster pump (9) and the Pelton turbine (11) are arranged on a common drive shaft (10), for a water desalination installation according to claims 1 to 7.

11. Use according to claim 10, the energy recovery unit further comprising a three-phase motor (12) for driving the pressure booster pump (9), whereby the number of revolutions of the three-phase motor (12) can be controlled by means of a variable frequency drive (13).